

# Current and Future Water Scarcity

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Rocky Mountain Research Station  
Forest Service, USDA



WHEEDON 4-29

# This talk will examine these topics at a broad spatial scale:

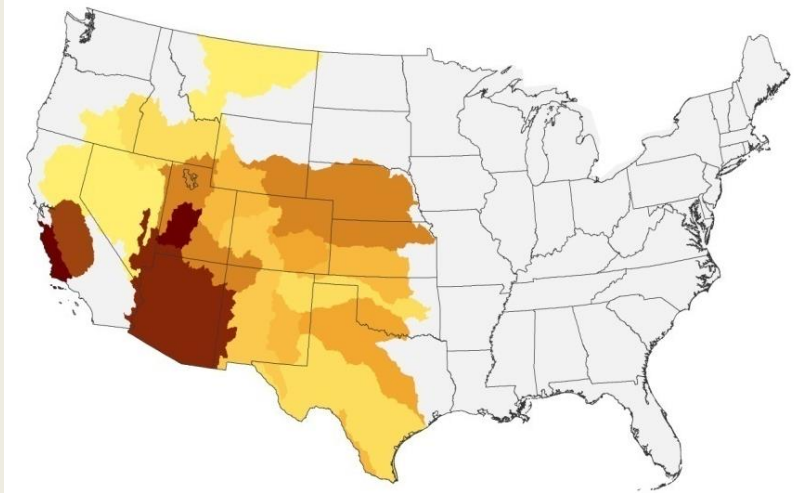
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1. Past and future off-stream water use
  - a. in non-agricultural sectors
  - b. for irrigation.
2. Potential water shortages.
3. Uncertainty about these things.

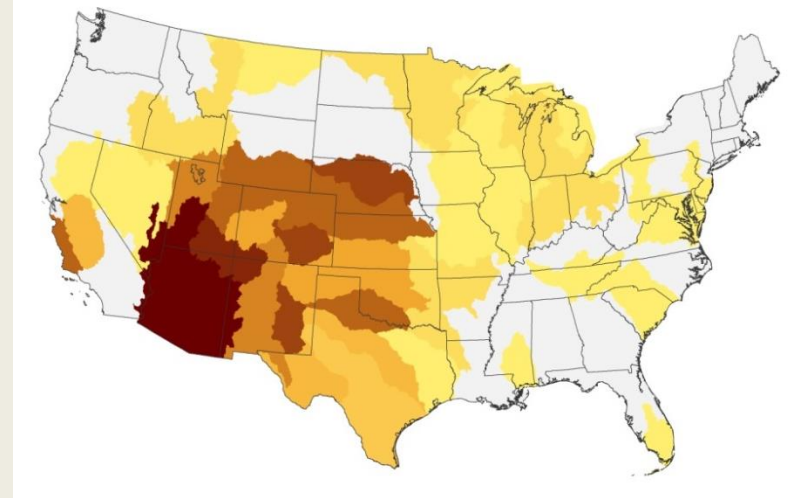
# Vulnerability in 2060, A2 socio-economic/emissions scenario

## Probability of water shortage with three global climate models

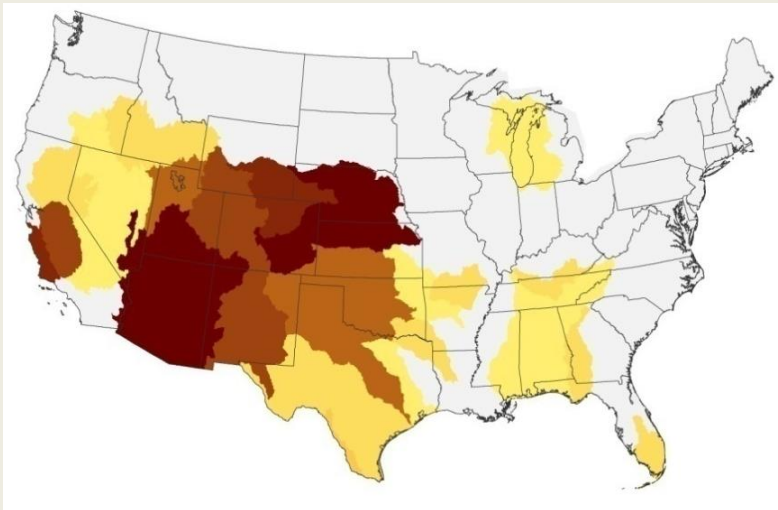
CGCM model



CSIRO model



MIROC model

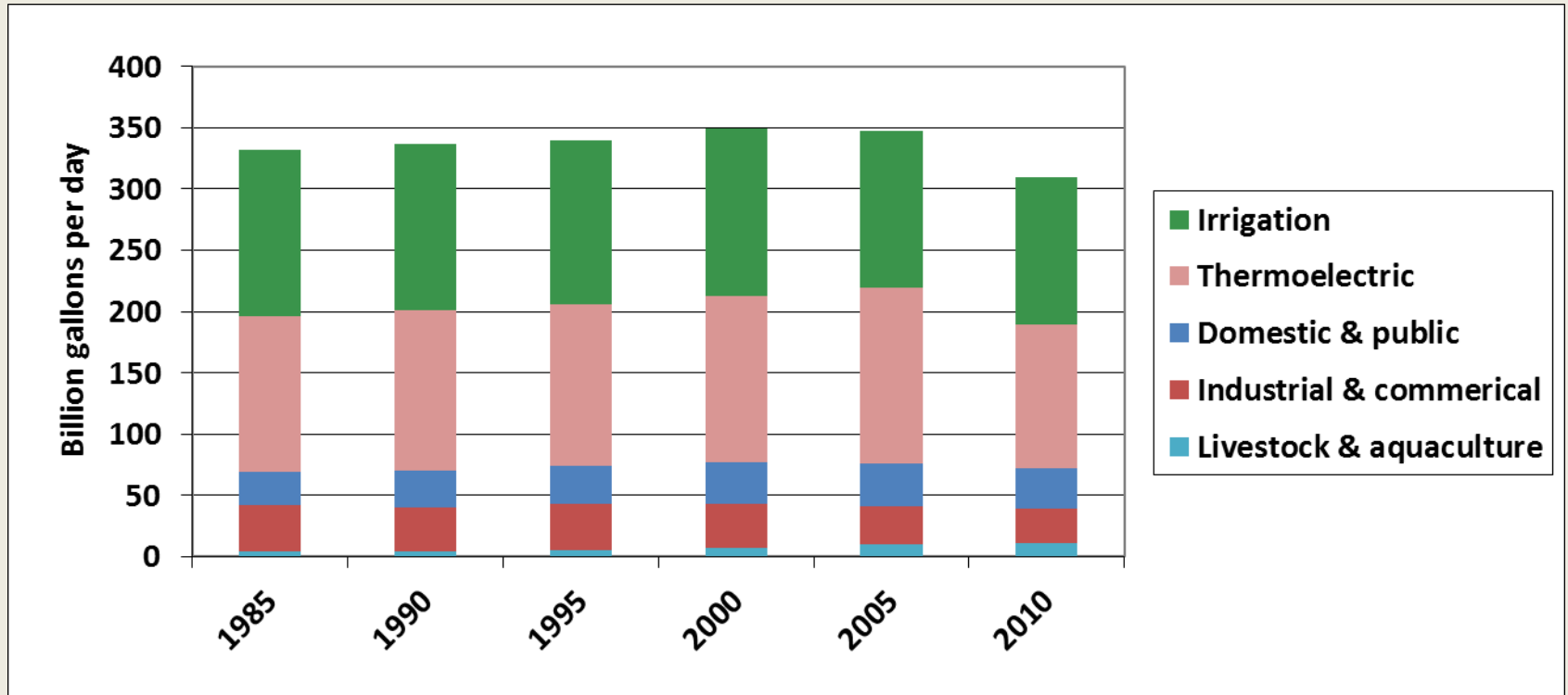


Upper end  
of category



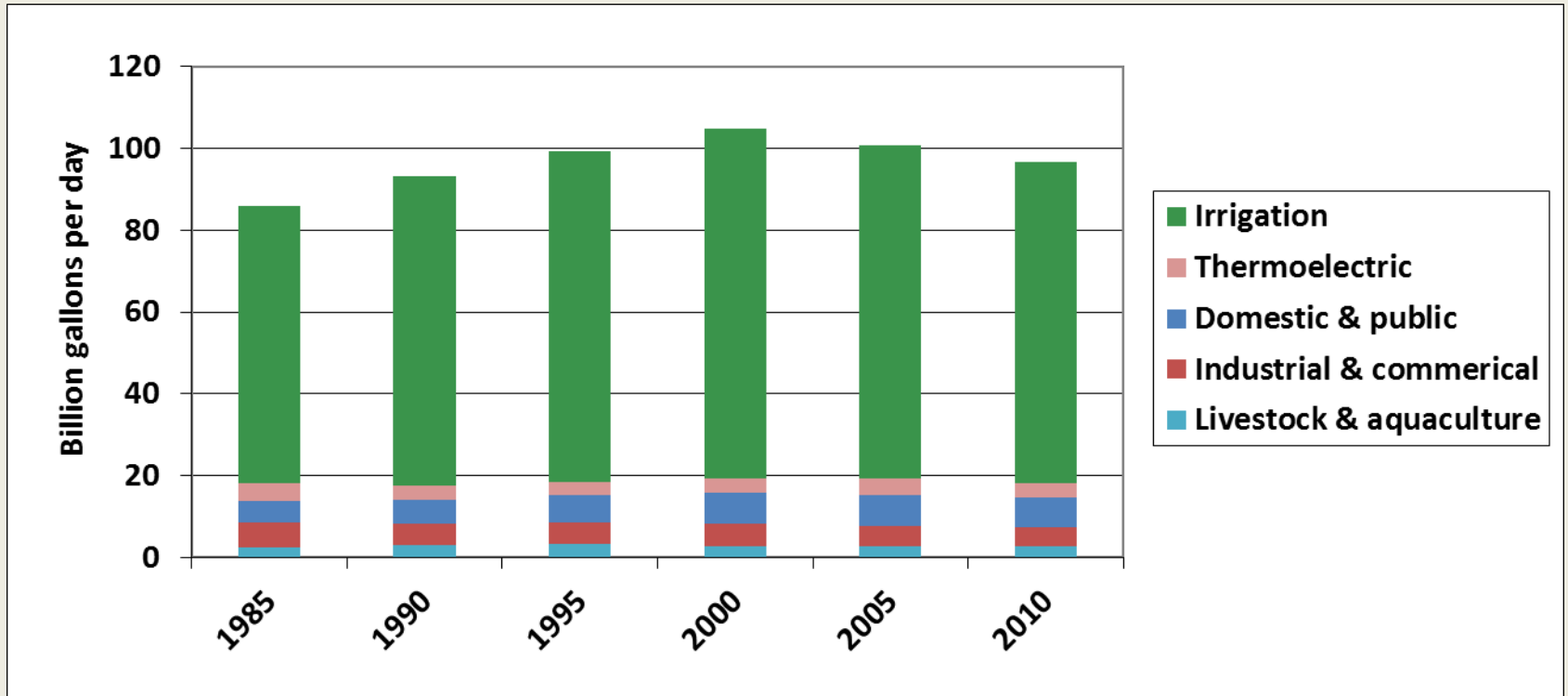
Source: 2010 RPA Water  
Assessment, Forest Service

# Total US annual water withdrawal by sector



Data source: USGS

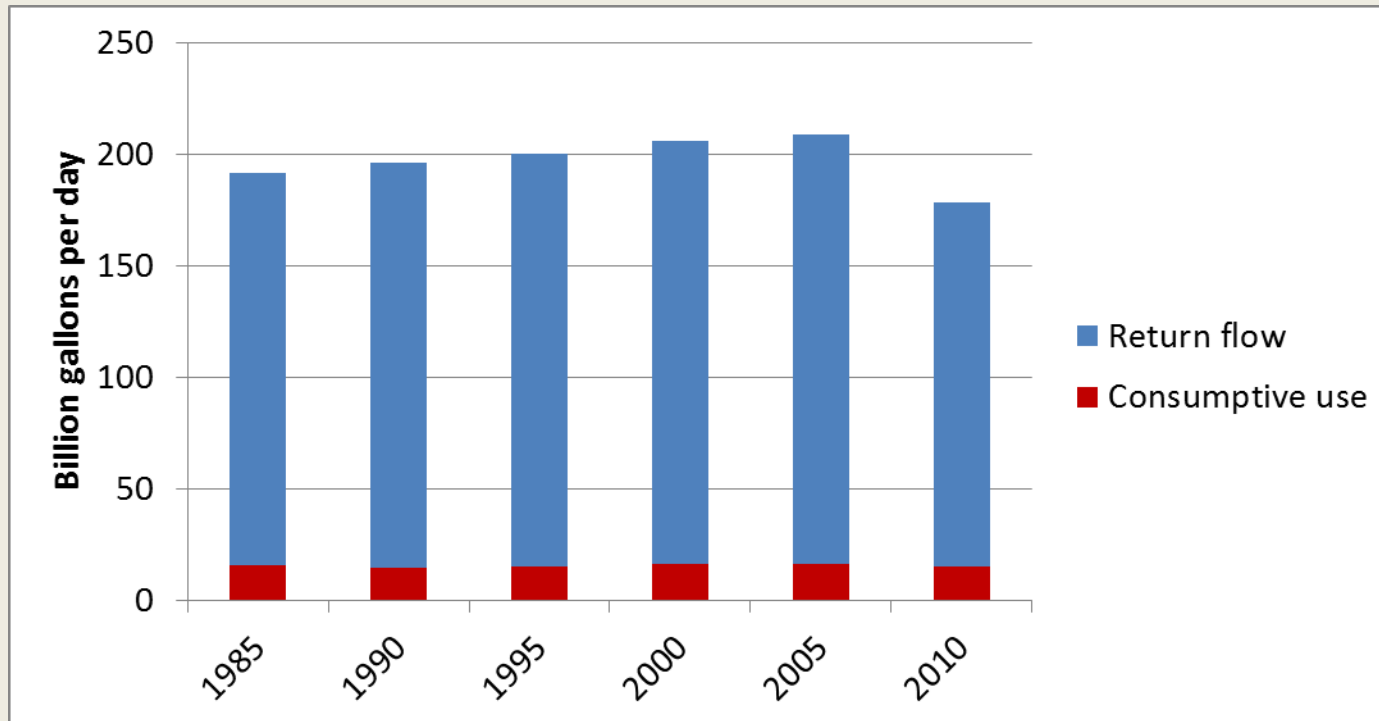
# Total US annual water consumption by sector



Data source: USGS, FS (RPA Water Assessment)

# Total US annual water use in non-irrigation sectors

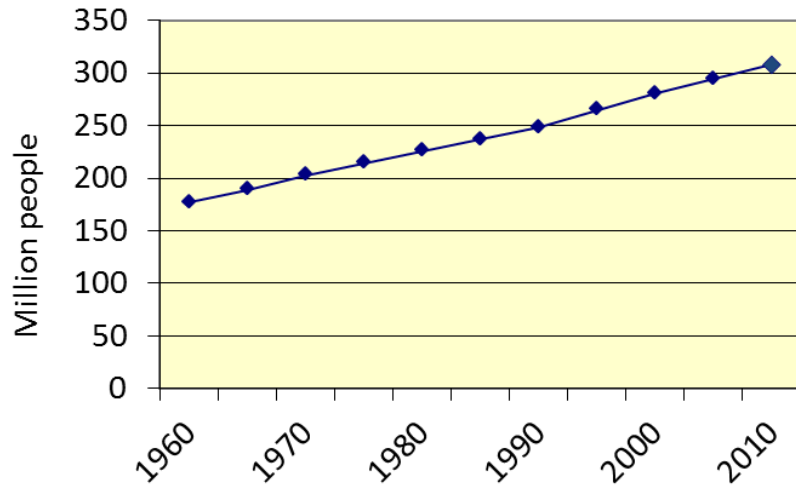
**Total withdrawal (consumptive use + return flow) of the domestic & public, industrial & commercial, and thermoelectric sectors**



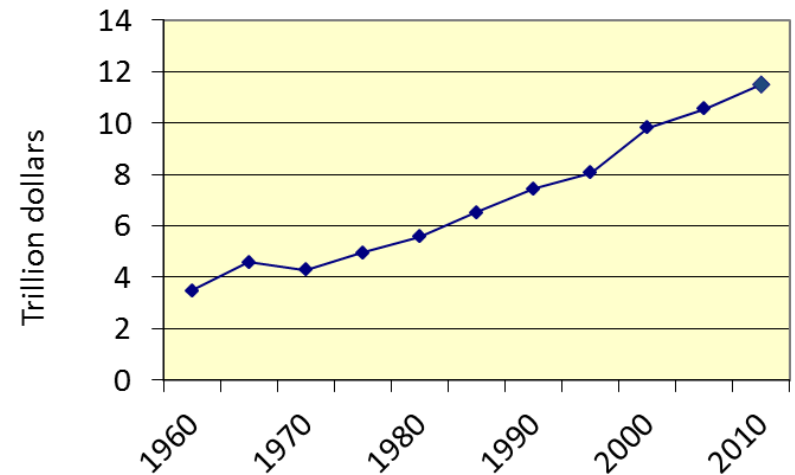
Data source: USGS, FS (RPA Water Assessment)

# Trends in water use drivers of major non-irrigation sectors

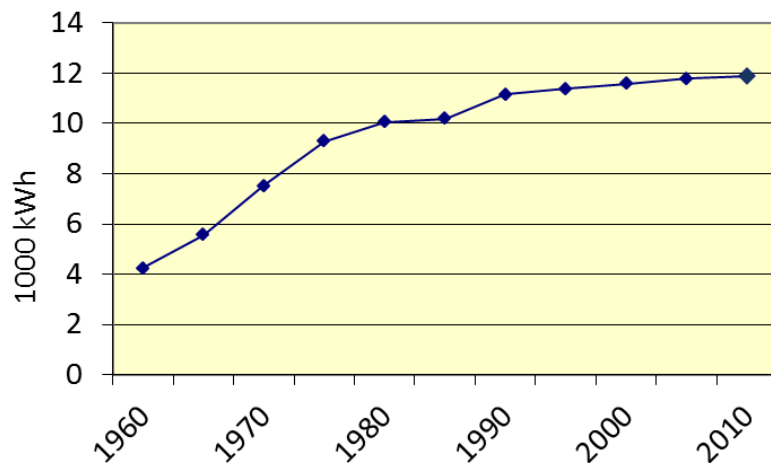
## Population



## Income per year (2006\$)



## Total electricity use per capita

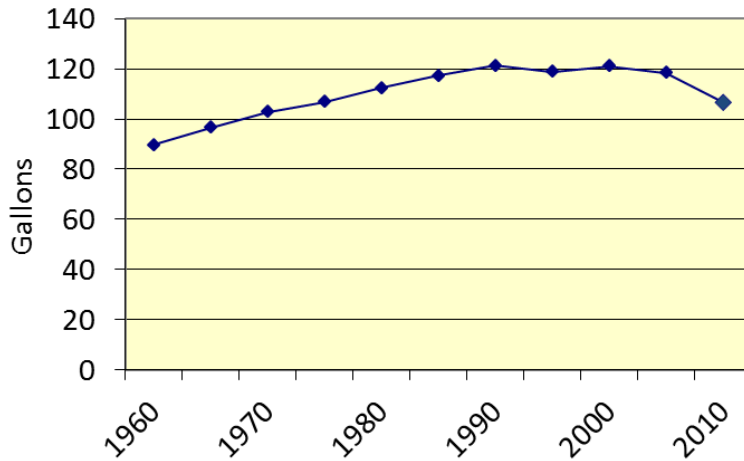


Data sources: BEA, EIA, Census Bureau

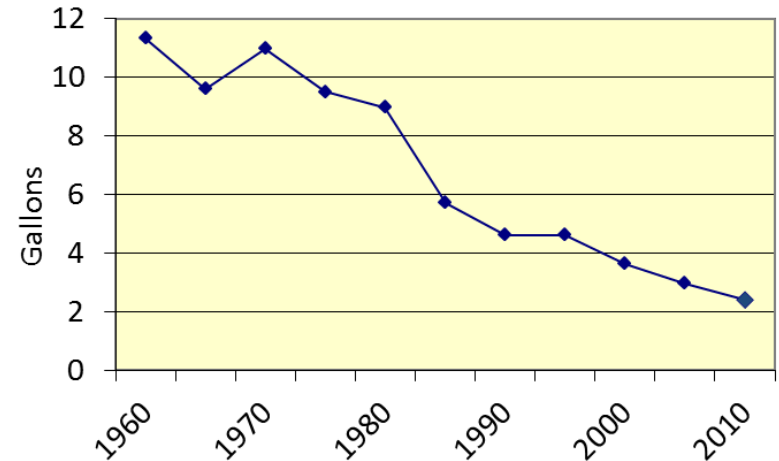


# Trends in water withdrawal rates of major sectors

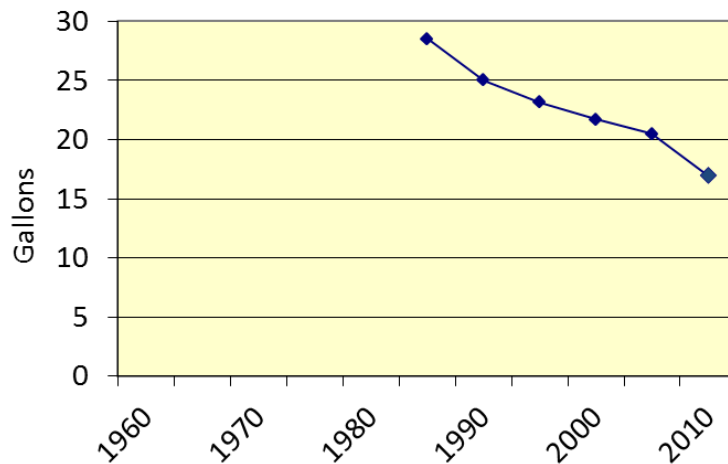
**Domestic and public withdrawal per capita per day**



**Industrial and commercial withdrawal per \$1000 of income (2006\$)**

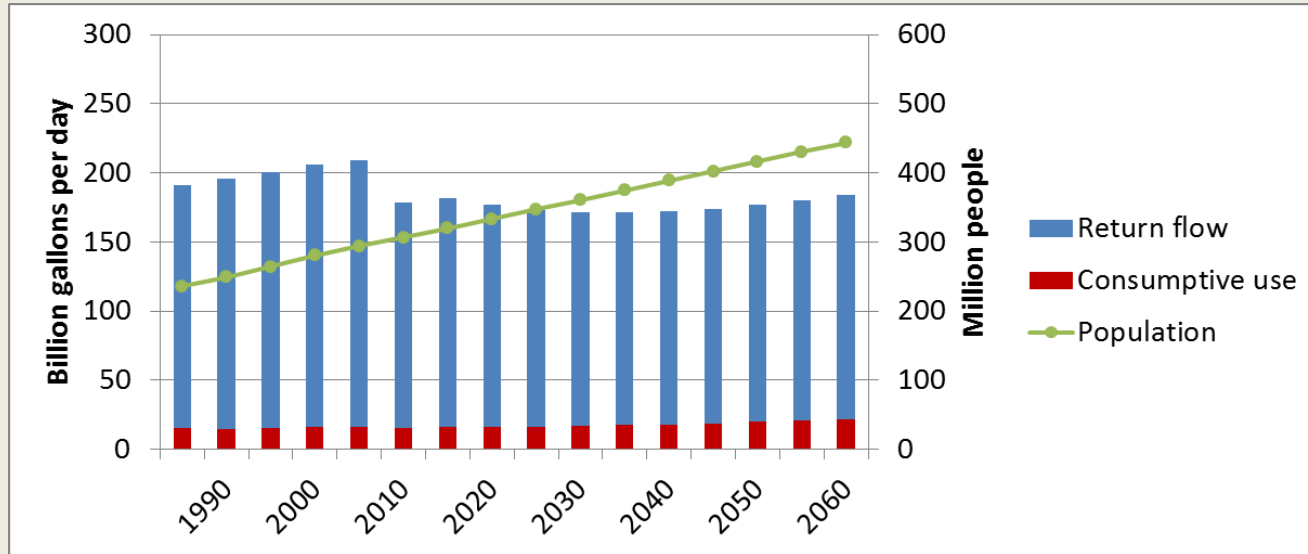


**Thermoelectric withdrawal per kWh produced**

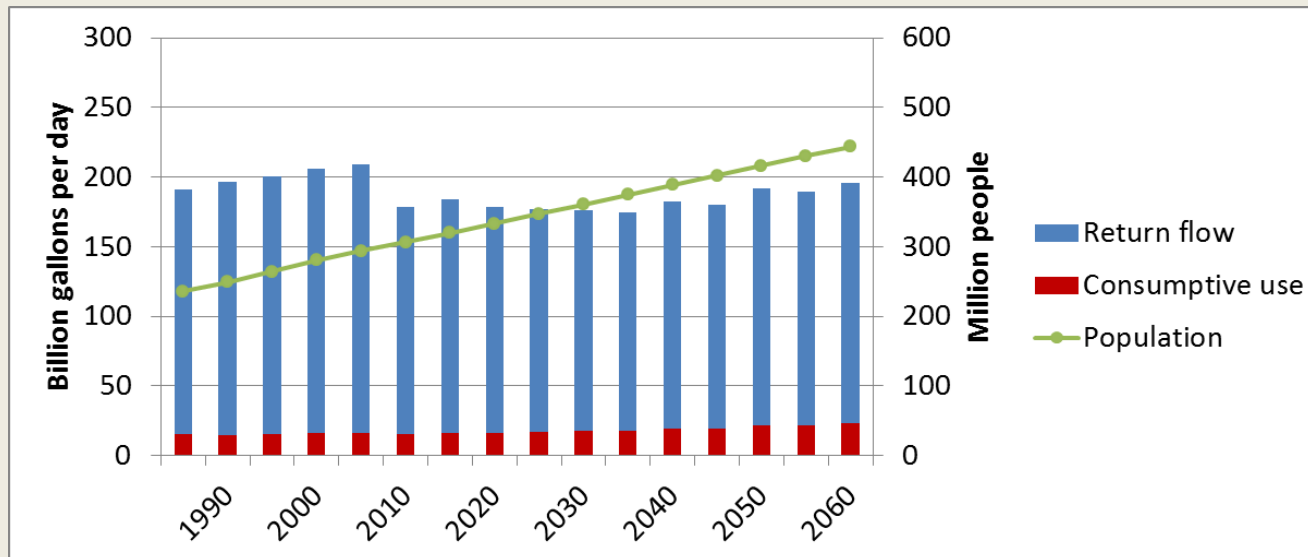


Data source: USGS, BEA, EIA, Census

# Past and projected US water use in non-irrigation sectors



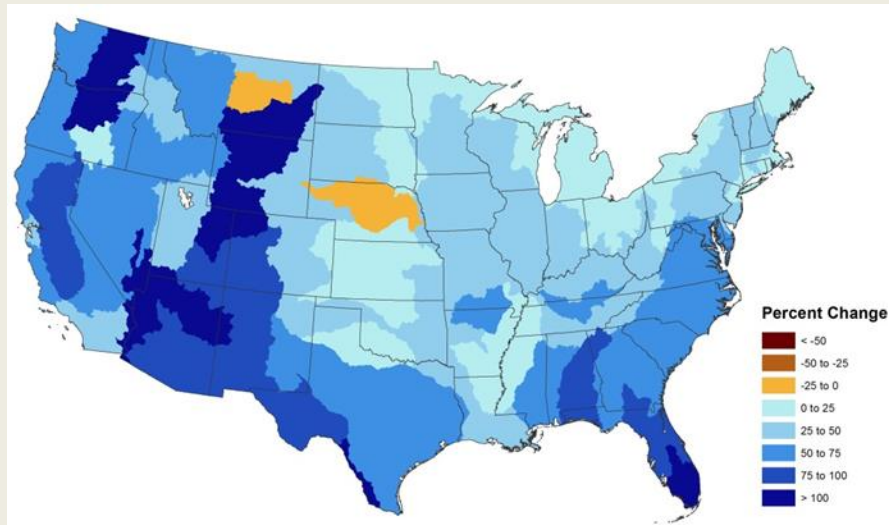
A1B population,  
**no climate  
change**



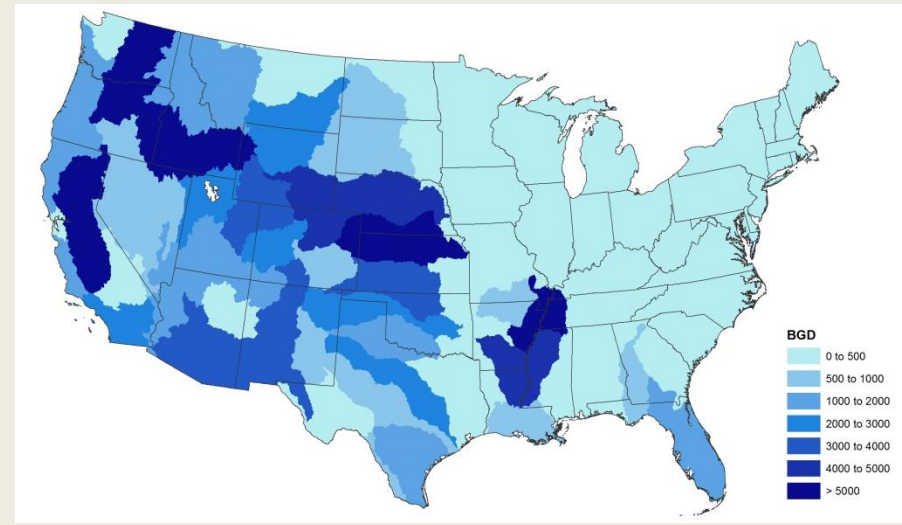
A1B population,  
**CGCM climate  
model**

# Irrigation withdrawal vs growth in competing water demands

Projected change in competing water use



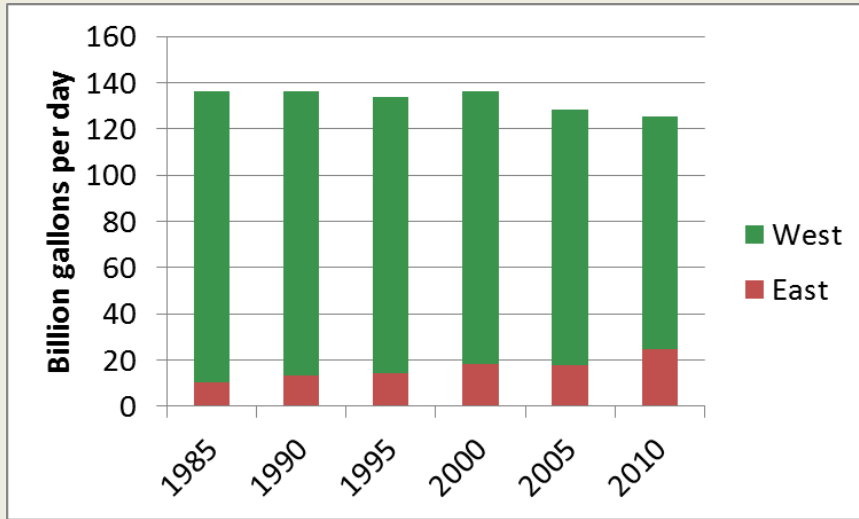
2010 Irrigation water withdrawals



The areas of greatest expected growth in water use in non-irrigation sectors (left map) are often the same as the areas of greatest current irrigation demand (right map).

# Water use for agricultural irrigation

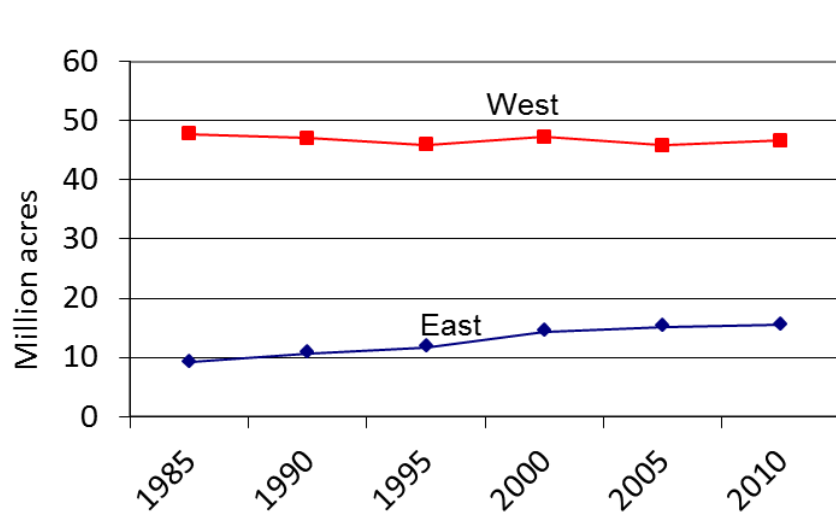
## Withdrawal



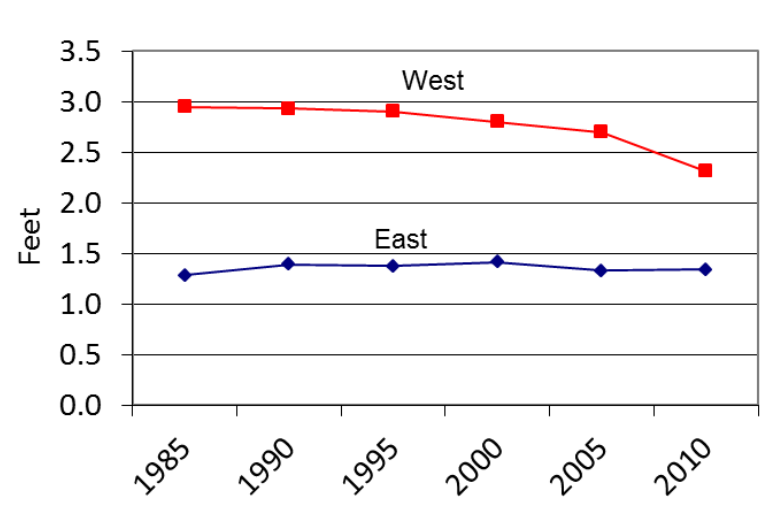
## West / East divide



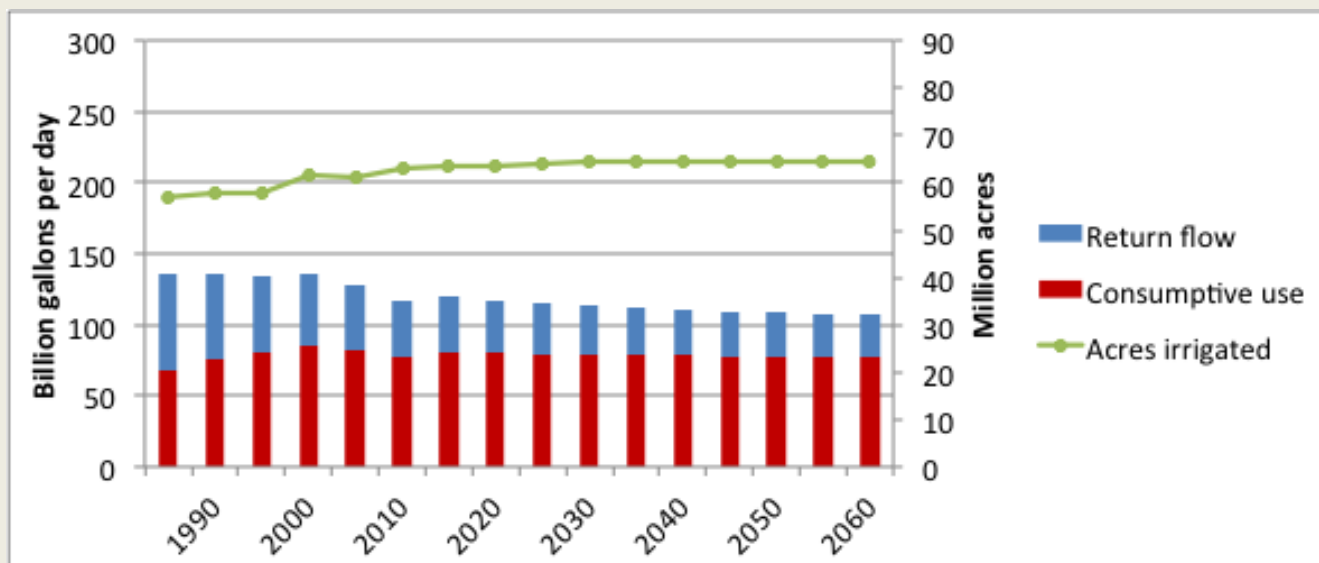
## Area irrigated



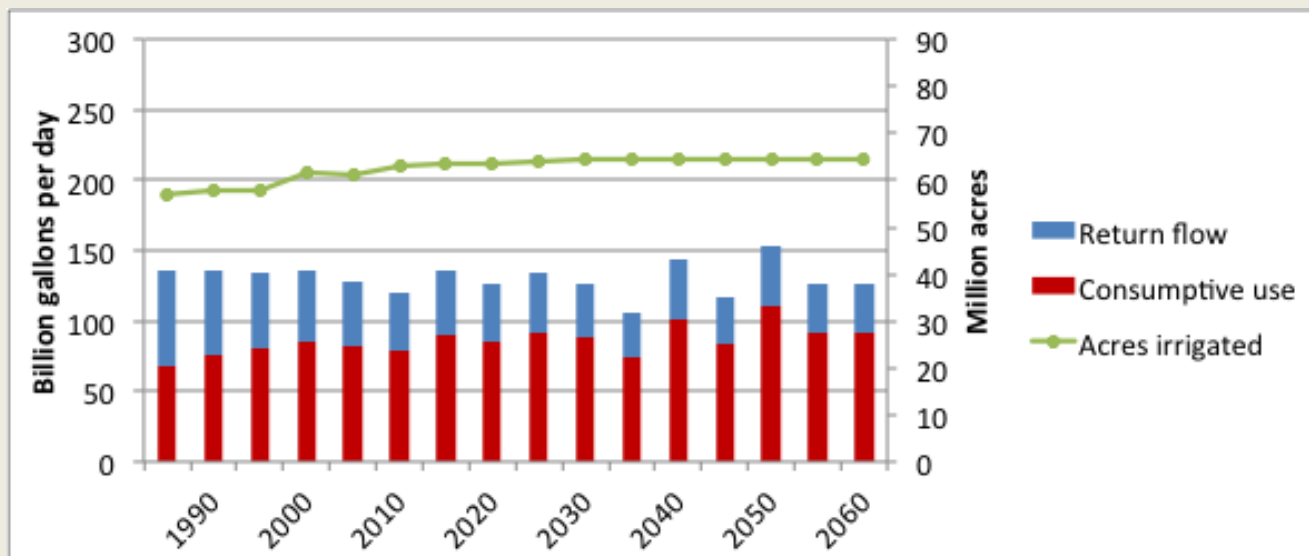
## Withdrawal per acre



# Past & projected US irrigation water use: effect of climate

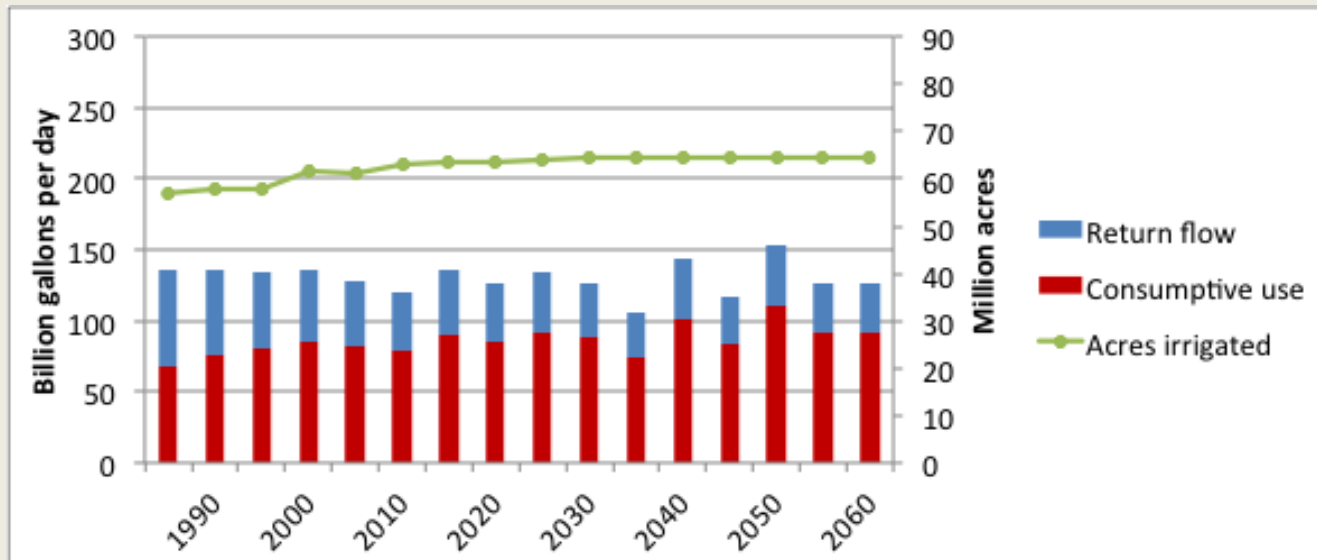


A1B population,  
no climate  
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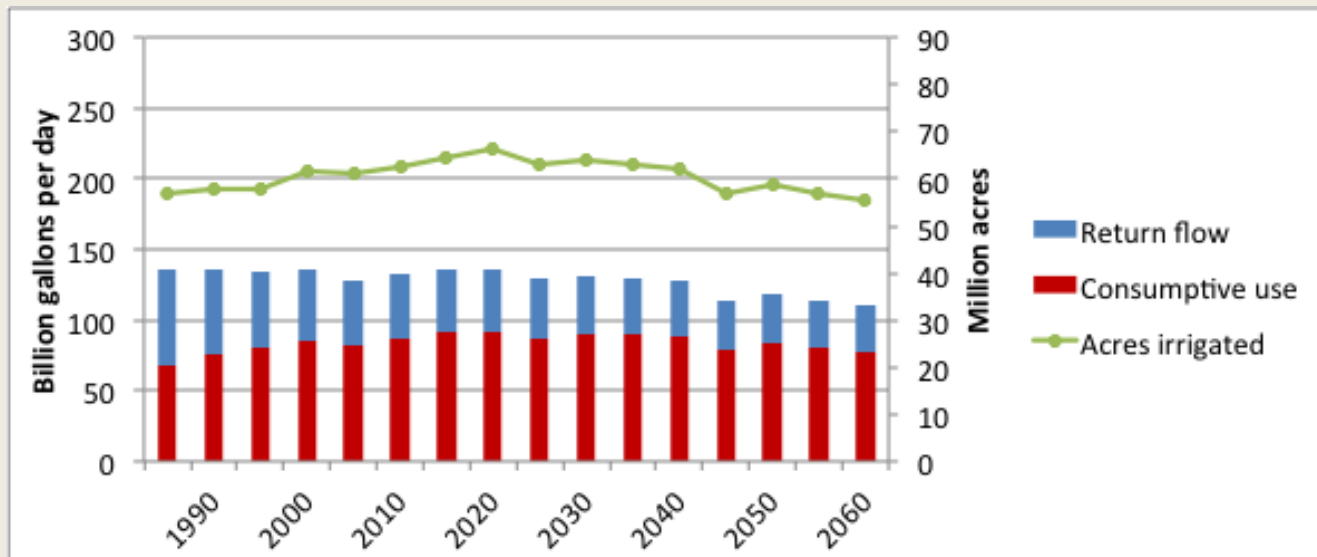


A1B-CGCM  
climate

# Past & projected US irrigation water use: effect of ag models

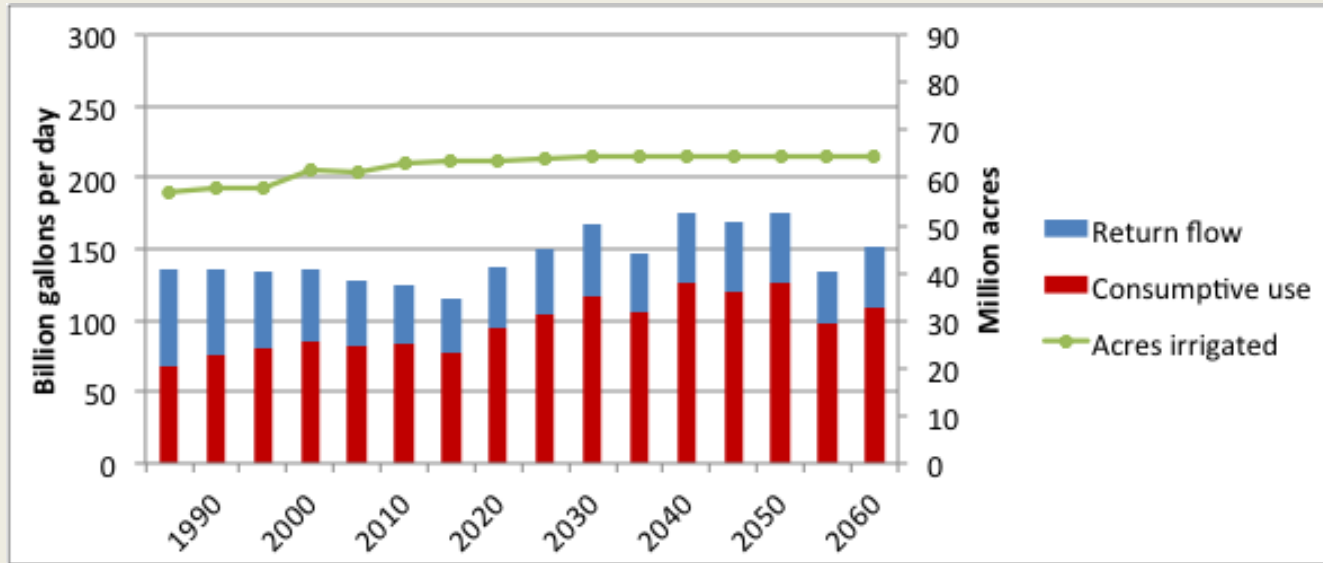


A1B-CGCM future,  
RPA

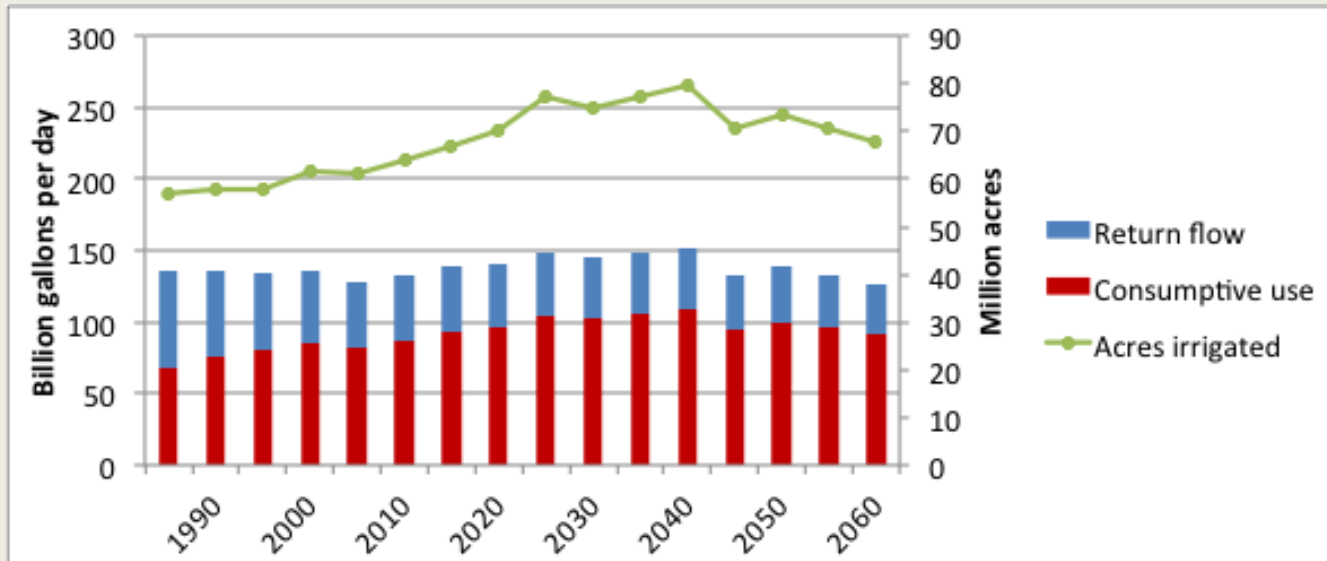


A1B-CGCM future,  
ERS

# Past & projected US irrigation water use: effect of ag models



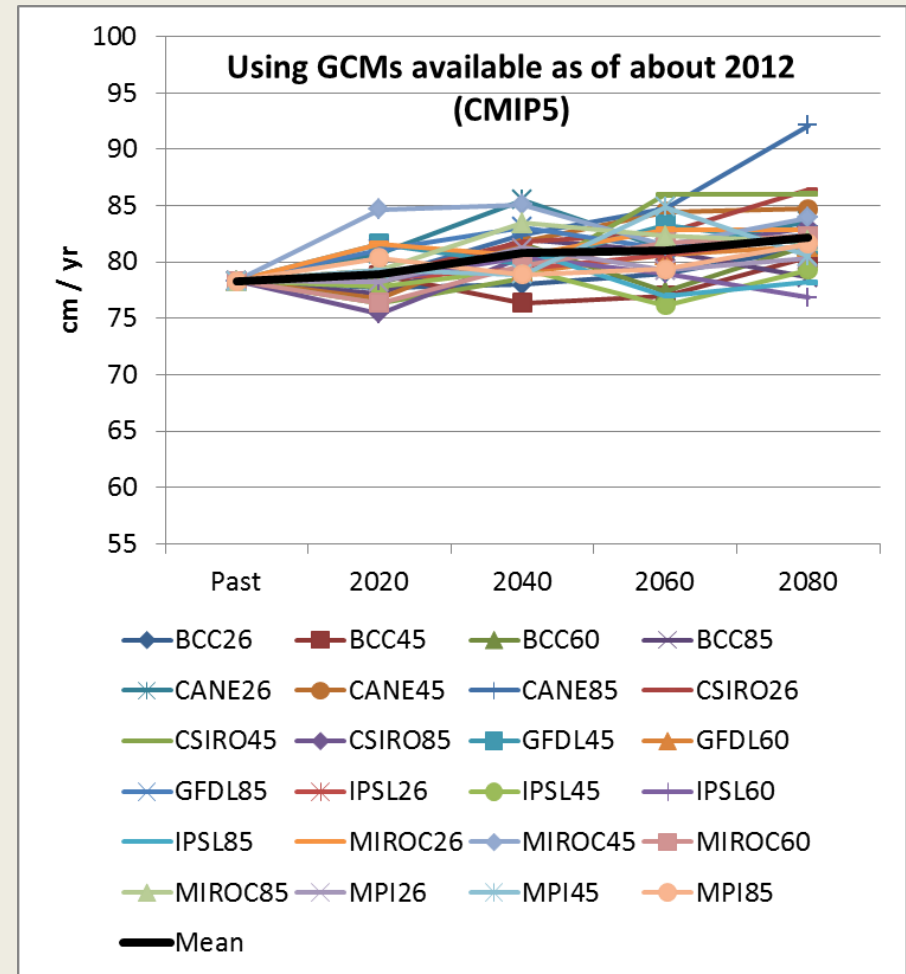
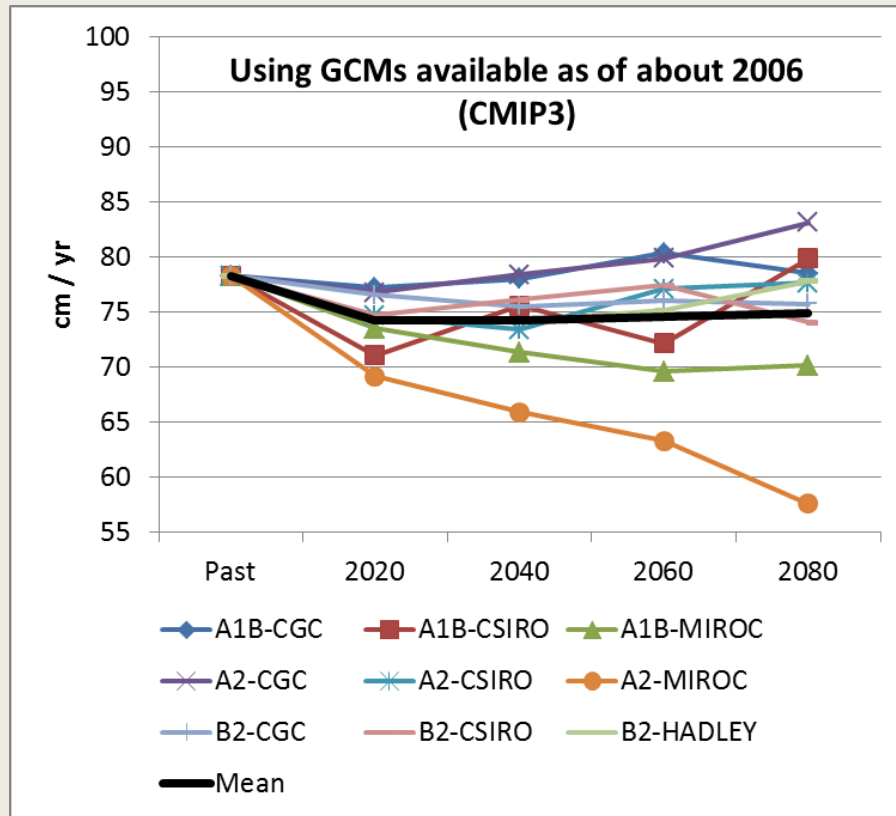
A2-CSIRO future,  
RPA



A2-CSIRO future,  
ERS

# Projected US average annual precipitation

Using two generations of global climate models: CMIP3 and CMIP5



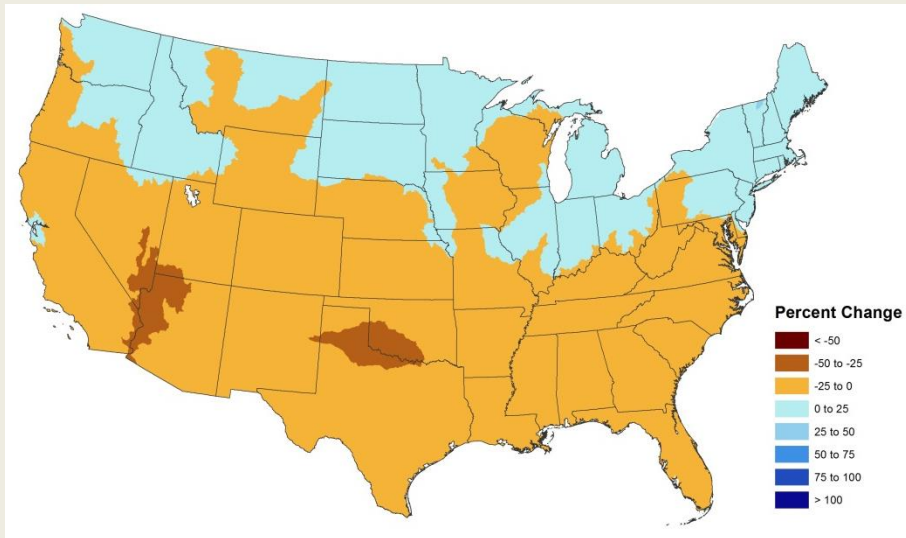
Data source: CMIP3, CMIP5



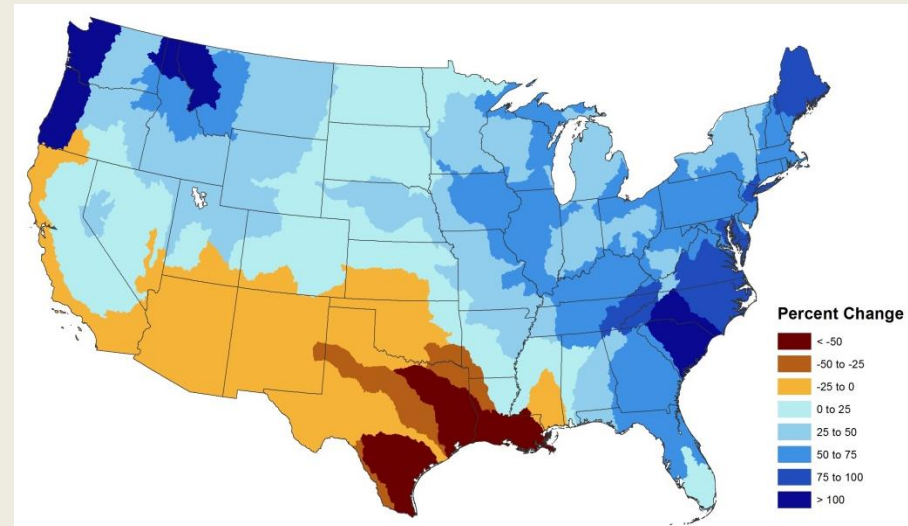
# Projected change in precipitation from two sets of models

Percent change from past period to 2060

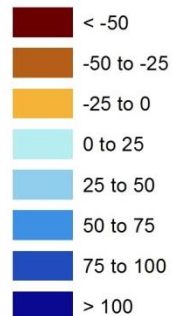
A2 scenario, CMIP3 multi-model average



RCP 8.5 scenario, CMIP5 multi-model average



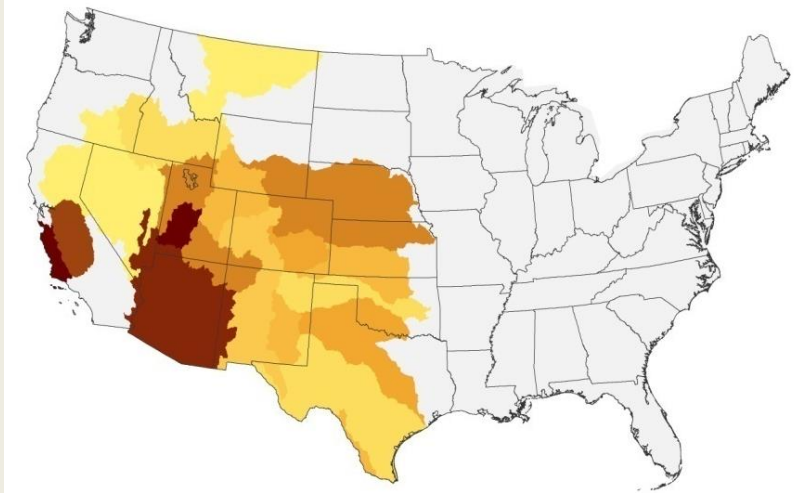
Percent Change



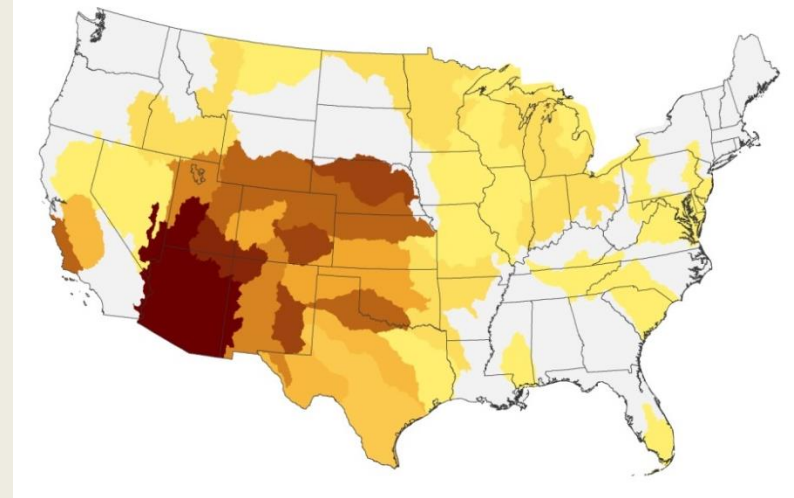
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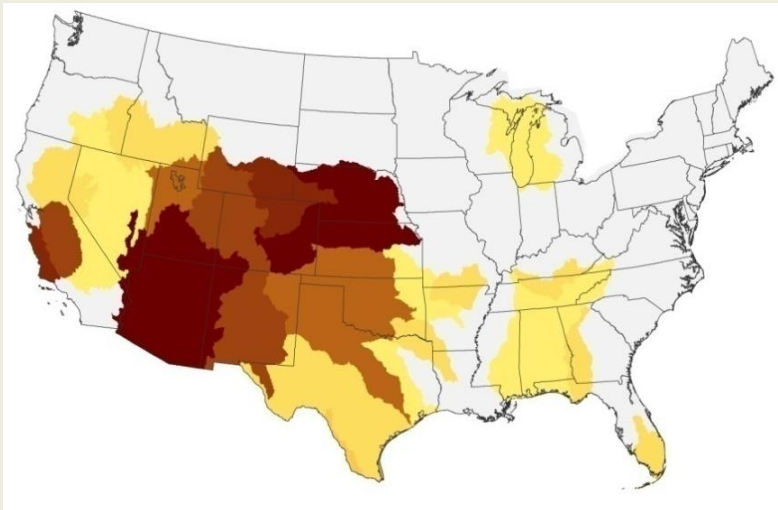
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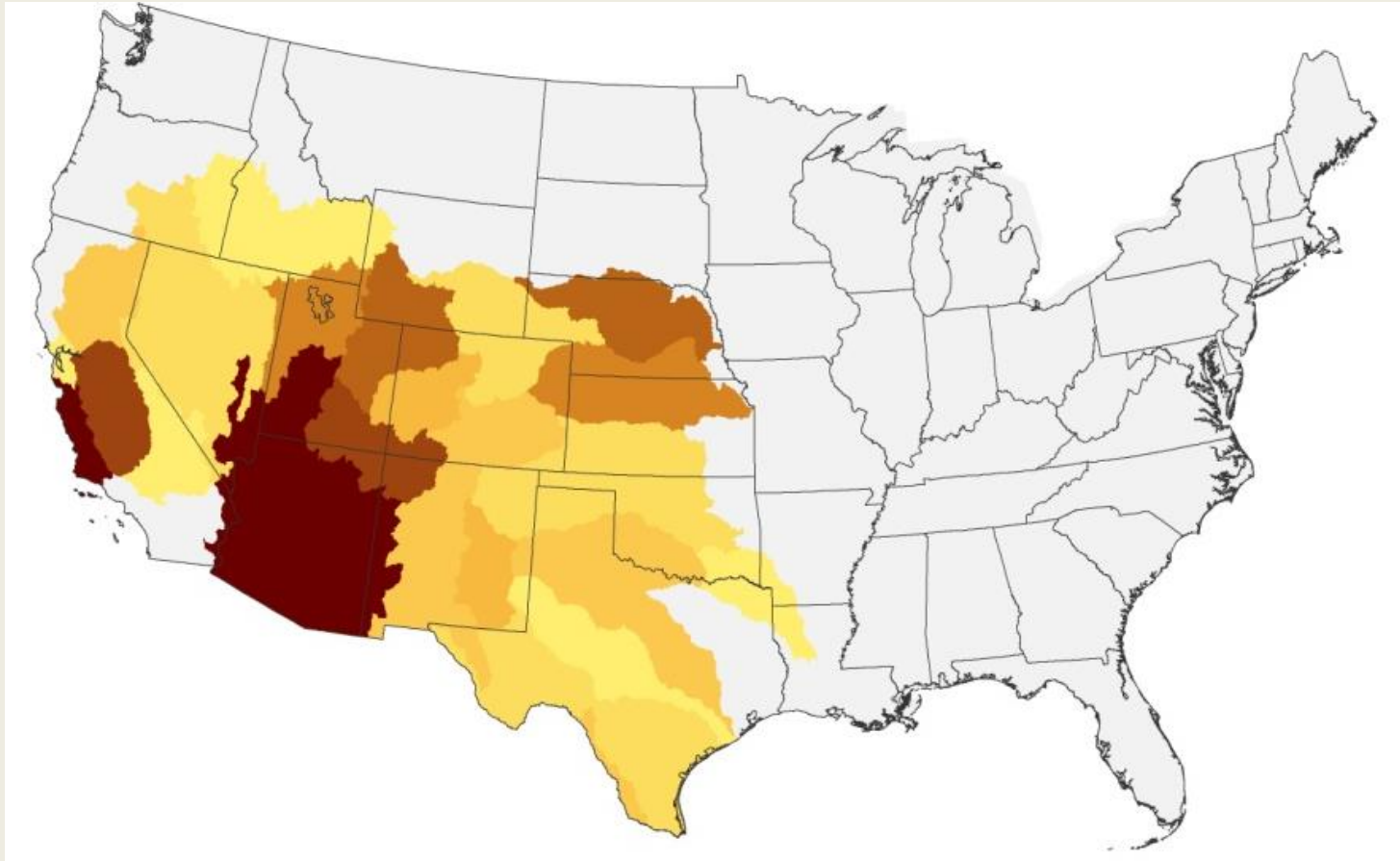
Source: 2010 RPA Water  
Assessment, Forest Service

## Wrap-up—key findings

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- **Water consumption in non-ag sectors is likely to gradually increase in response to rising population, despite dropping withdrawal per capita.**
- **Climate change will further increase water use in non-ag sectors.**
- **Climate change could actually decrease irrigated area and water application in many areas.**
- **New climate models project generally increasing precipitation over much of the US, but serious decreases in the Southwest, southern Plains, and coastal California.**
- **Of course, rising temperatures will increase evapotranspiration, which will reduce water yield even in areas of moderate precipitation increase.**
- **Considerable uncertainty remains about the specific level of demand, supply, and vulnerability.**
- **In general, the larger Southwest, including parts of California, the Great Basin, and the central and southern Great Plains, are likely to experience increasing water supply vulnerability in the absence of new adaptation measures.**

This is not a picture of what will be.  
It is a picture of the adaptation challenge we may face.



Thank you